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ABSTRACT

Traditionally, reading disabled children have been characterized as suffering a performance or process deficit that prevents them from acquiring the knowledge and skills underlying proficient reading and comprehension. Such explanations raise some logical problems. Process oriented theories do not adequately explain the specificity nor address the severity of the disability. The process-deficit view has also run up against disconfirming empirical evidence. An alternative conceptualization of the nature and growth of reading disability states that the fundamental problem lies in the difficulty in mastering the complex irregular rules of English symbol-sound correspondences. This in turn hampers development of rapid word decoding. Having to expend effort at decoding for meaning, the reader has little capacity for higher order reading and comprehension skills. Previous research, as well as recent tests using regular and irregular vowel sounds and words of varying difficulty in symbol-sound correspondence, bear out the hypothesis that mastery of these three skills is primary to reading. Severity of the reading disability stems from the interdependence of these three skills. (HTH)

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Reading disability: toward a reconceptualization

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Reading disabled children comprise a subgroup of poor readers distinguished by scoring at approximately normal levels on standard aptitude tests and who suffer no major sensory, neurological or emotional problems (Gibson & Levin, 1975). Disabled readers often score close to grade level in other scholastic areas, such as mathematics (De Vries, Morrison, Foster & Wolford, 1981; Trites & Fiedorowicz, 1977; Yule, 1973). In reading acquisition, disabled readers experience greatest difficulty progressing beyond the word level and obviously show major problems in developing comprehension skills (Fleischer, Jenkins & Pany, 1979). Some have reported that they have a history of language problems in early childhood (Vellutino, 1977).

Search for the underlying nature and cause(s) of specific reading disability has proceeded for almost a century. At different times reading disabled children have been labelled as suffering from various specific cognitive deficits, from perceptual to attention to memory problems. Yet explanation of this puzzling disorder has eluded investigators to the point where some are claiming that no unitary set of principles will explain the problems of all reading disabled children (Applebee, 1971; Doehring, 1978). Despite a diversity of explanations there is a common underlying theme to these interpretations. Essentially the reading disabled child is seen as suffering a deficit in the performance of one or more elementary cognitive processes. Failure of one (or a subset) of processes to explain the disability may not reflect the diversity of the disorder so much as an inherent flaw in the conceptualization of the problem. In this paper I would like to briefly review the logical and empirical status of current process-deficit views of reading disability. The evidence shows that such explanations are limited in their explanatory power, and they run counter to a growing body of scientific literature.

then I will outline a different conceptualization including results of some preliminary studies derived from this view.

TRADITIONAL VIEWS

Traditionally reading disabled children have been characterized as suffering a performance or process deficit which prevented them from acquiring the knowledge and skills underlying proficient reading and comprehension. While such explanations were intuitively reasonable, they raised some thorny logical problems.

First, process-oriented theories never adequately explained the specificity of the disorder: namely why the disability was limited primarily to reading acquisition (Vellutino, 1977). If the disabled reader suffered a general problem in perception or short-term memory, surely deficits would manifest themselves in everyday cognitive functioning or in other academic subjects. Second, such views did not address the severity of the problem: specifically how a child suffering from a mild short-term memory problem could obtain a normal I.Q. score while barely advancing beyond the word level in reading acquisition?

Third, process views seldom elucidated the causal connection between the underlying process deficit and the reading problem; for example, how a perceptual deficit produces problems in learning words.

Empirical evidence. Apart from logical problems, the process-deficit view has run up against an impressive body of disconfirming empirical evidence. Research on the major processes hypothesized to underlie reading disability - perceptual deficit, attentional deficit, serial ordering deficit, short-term memory deficit, and phonetic coding deficit - has failed to confirm their causal status. Deficits which have been observed, essentially in speeded processing or in use of a processing

strategy, can best be explained as a result of failure to acquire basic reading knowledge and skills.

Since complete review of the literature is impossible here, I would like to illustrate the above points by describing three studies which disconfirm specific process deficit hypotheses and highlight the nature of processing differences observed.

Perceptual deficit . One study in our laboratory (Morrison, Giordani & Nagy, 1977) examined the popular notion that disabled readers suffer a deficit in basic perceptual functioning. Using a standard partial-report procedure, we found no differences between normal and disabled readers in early perceptual processing stages (0-300 msec.) measuring amount of information initially available and trace duration of information in the visual sensory register) while major differences emerged during later stages (450-2000 msec.) which have been shown to reflect speed and strategy of serially encoding multi-item arrays (Schwantes, 1980).

Short-term memory. Bauer (1979) presented normal and disabled readers with a standard free recall task. Examining serial position curves, he found no group differences on recency portions but major differences on primacy portions, with normal readers showing stronger primacy effects than disabled readers. The results clearly disconfirmed hypothesized deficits in short-term memory in disabled readers and pointed to problems in mobilizing or executing effective serial rehearsal strategies. Other evidence against a strict short-term memory deficit has been gathered by Perfetti and Hogaboam, (1975).

Phonetic coding. Finally a recent study by Wolford and Fowler (1981) examined the hypothesis that disabled readers suffer a fundamental problem in coding information into a phonetic form (Liberman & Shankweiler, 1980; Vellutino, 1977). They chose two tasks specifically designed to produce separate kinds of confusion errors; a full-report procedure in which confusion errors are almost exclusively based on visual similarity and a Conrad procedure which produces primarily phonetic confusion. Normal readers outperformed disabled readers on both tasks. Further, analysis of confusion errors confirmed that visual confusions occurred in the full-report task while verbal confusions predominated in the Conrad task. These results demonstrated clearly that phonetic coding is not uniquely responsible for performance differences between normal and disabled readers.

In sum, process-deficit explanations of reading disability have encountered some formidable logical and empirical problems. Based in part on integration of evidence from diverse sources we have developed an alternative conceptualization of the nature and growth of reading disability. In brief, our proposal states that:

1. The fundamental problem experienced by the disabled reader lies in acquiring knowledge about words and how they are pronounced. Difficulties in acquiring word knowledge stem from the child's failure to master the complex, irregular system of rules governing symbol-sound correspondences in English. The rule-learning difficulty in reading may represent a problem in learning complex or irregular rule systems in general.
2. Failure to learn correspondence rules hampers the child from developing rapid, automated word decoding operations.
3. Having the expend effort at simply decoding words for meaning, the disabled reader has little residual capacity to devote to higher-order

reading skills and comprehension (LaBerge & Samuels, 1974).

4. Performance deficits on cognitive processing tasks stem from a failure by disabled readers to develop skills which themselves result from acquisition of higher-order reading and comprehension skills.

We will expand on these points including some preliminary data we have collected. Finally we will attempt to address the logical and theoretical problems faced by other theories, namely to explain the specificity and severity of the reading disorder.

1. RULE LEARNING AND WORD KNOWLEDGE

There is considerable evidence that the early phases of reading acquisition are primarily an implicit rule learning process (Gibson & Levin, 1975; Rozin & Gleitman, 1977; Venezky, 1976). By third or fourth grade, children have mastered basic correspondence rules which allows them to identify pseudowords not previously seen (Calfee, Venezky, & Chapman, Note 1; Guthrie & Seifert, 1977). Further, rate of acquisition of different correspondence rules has been shown to vary with the complexity or irregularity of the rules governing them, despite equal exposure in the curriculum (Guthrie & Seifert, 1977). Finally there is indirect evidence that the complexity or irregularity of the system is particularly difficult for the disabled reader. For example, though clearly not conclusive, there is suggestive evidence that severe reading disorders are much rarer in language communities like Japan and Findland (Kyostio, 1980; Makita, 1968) than in the United States or Great Britain. One major difference among the communities is that the symbol-sound correspondences in Japanese Hiragana and in Finnish are simpler, more regular, with fewer exceptions than are the correspondences in English. Additional evidence comes from studies of word pronunciation in English. Shankweiler and Liberman (1972) found that disabled readers made considerably more pronunciation errors on vowel units than on consonants, whereas errors of above average

on vowel units than on consonants, whereas errors of above average readers were more nearly equivalent. They pointed out that vowels may be more difficult for disabled readers due to the complexity of the correspondence rules. Indeed, they found that the error rate on particular vowels was correlated with the number of orthographic representations of each vowel phoneme, suggesting a role of rule complexity in reading errors.

In a recent study in our laboratory (Manis, Morrison & Langoussis, 1981) normal and disabled readers in grades two through six were required to pronounce 60 pseudowords constructed according to correspondence rules of varying complexity. Overall the results replicated Shankweiler and Liberman (1972) in finding that disabled readers performed differentially poorer on vowels versus consonants than did normal readers. In addition some interesting findings emerged within each letter class. For initial consonants (see Figure 1) accuracy was almost equivalent between normal and disabled readers on consonants like "m", "n", "p" and "t", those with only one pronunciation in initial position. In contrast on initial consonant "c" which has both a hard and a soft pronunciation in initial position, disabled readers performed much worse than normal readers. Moving to the vowels, we examined accuracy of pronunciation of short vowels (e.g., bap, ren, bin) and long vowels (bape, tene and bine) following the "silent-e rule." Figure 2 illustrates that accuracy of pronunciation of short vowels was inferior in disabled readers. However, as seen in Figure 3, with the exception of the letter "i", the degree of difference between normal and disabled readers was greater still for long vowels, whose pronunciation rules are more irregular.

Finally it is worth noting that even when we matched second grade normal with sixth grade disabled readers on reading level, normal readers still outperformed disabled readers a difference that is hard to account for on the basis of differential exposure to consonants and vowels.

In sum, evidence is suggestive that at the root of the disabled reader's problem lies a failure to master the complex and irregular system of rules governing symbol-sound correspondences in English.

A GENERAL RULE-LEARNING PROBLEM?

One implication of the present conceptualization is that disabled readers might have a general deficit learning irregular rule systems. If substantiated, this hypothesis would explain why mathematics is easier than reading for disabled readers and it would also help explain the language problems reported in these children. The rules governing manipulation and combination of mathematical symbols, at least for beginning math, are relatively invariant. In contrast the rules governing e.g., English syntax are complex and filled with exceptions. In a recent study we examined learning of an arbitrary rule system with either regular or irregular rules. Normal and disabled readers were taught an arbitrary set of rules governing combinations of colored squares. Figure 3 illustrates the different conditions. In the regular condition subjects learned six regular rules which never varied (e.g., black square + yellow square yields black square). In another condition subjects learned three rules and three exceptions (e.g., black + yellow = black except if squares are tilted, then black + yellow = green). Four study-test trial blocks were given. Results, shown in Figure 5, revealed that rate of learning the regular rules was virtually identical in normal

and disabled readers. In marked contrast, in the irregular rule condition, normal readers performed better then they did in the regular rule condition, while disabled readers performed much worse, essentially showing very little learning in the irregular rule condition.

The pattern of results suggested that disabled readers may have a general problem in learning rule systems that contain exceptions or are otherwise irregular.

DEVELOPMENT OF AUTOMATIC WORD DECODING SKILLS

Apart from learning to decode words accurately, some theorists have argued that decoding must also become automatic in order to reduce the processing demands of lower-order operations such as word recognition, in favor of higher-order operations such as comprehension of meaning (LaBerge & Samuels, 1974; Perfetti & Hogaboam, 1975). To the extent that decoding remains effortful and slow, it will interfere with other aspects of reading. Perfetti and others (Ehri, 1976; Golinkoff & Rosinski, 1976; Pace & Golinkoff 1976) have reported evidence that poor readers have poorly automatized decoding skills. In a recent study (Manis, Morrison & Langoussis, 1981) we examined growth of automatic word decoding skills in normal and disabled readers as a function of word difficulty. A set of low frequency real words was divided into low difficulty (e.g., nib, gaff, gannett) high difficulty (e.g., lyre, lute, scaup) and irregular (gel, lock, trough) sets, primarily on the basis of vowel rules. Normal and disabled readers learned to pronounce the words across three testing sessions. Performance on these unfamiliar words was compared to performance on a set of highly familiar control words (e.g., dog, story, father). To the extent that the unfamiliar words become automatized, the latency for vocalizing unfamiliar words should

converge on latency for vocalizing familiar words. The results, depicted in Figure 6, revealed that latencies converged quickly for normal readers. By session 3, normal readers were as fast on all sets of unfamiliar words. In contrast, latencies remained high across the sessions for disabled readers, and were highest for high difficulty and irregular words, suggesting that difficulties in applying complex rules interfered with automatization. Together with other evidence on rule learning problems (Guthrie, 1973a; Guthrie & Seifert, 1977; Mason, 1976; Shankweiler & Liberman, 1972; Snowling, 1980), the results point to a link between failure to acquire rules and problems in developing automatized decoding skills.

PERFORMANCE/PROCESSING DEFICITS

Processing deficits of disabled readers are most pronounced in tasks requiring rapid encoding, scanning and rehearsal of multi-item arrays. It is possible that processing difficulties stem from failure to have developed sophisticated reading skills (Deutsch, 1978). For example, in a recent study Schwantes (1980) demonstrated in a group of same age children that greater reading ability was associated with increased left-to-right scanning in processing a linear array of briefly presented letters. In like fashion the growth and utilization of sophisticated rehearsal strategies may be influenced in part through development of more complex reading skills. Several models of reading posit that individually encoded words must be maintained and integrated in short-term memory in order to facilitate extraction of meaning and text comprehension (Gough, 1972; Perfetti & Lesgold, 1978). Clearly recycling or sustaining previously read information represents a elementary form of rehearsal and may shape the general development of rehearsal skills.

WHY READING?

From our analysis we would contend that reading acquisition represents a relatively special case where mastery of three important tasks must be accomplished. First the child must master the rules governing symbol-sound correspondences in English. Second the child must use those rules in learning to decode words and must progressively refine and automate basic word decoding operations. Third, building on automated decoding skills, the child must acquire a complex set of processing and comprehension skills. Of the many tasks facing the child it is primarily in reading that the unique mastery of all three skills is required. In learning early mathematics, for example, less difficulty is posed by the system of rules governing addition, subtraction, multiplication and division. Further there is less pressure to develop sophisticated processing and memory skills, since the outcomes of mathematical operations are often written down and can be consulted later. The only other system that approximates reading in requiring mastery of these three component tasks is language. Composed of a system of complex, often irregular rules, language acquisition requires rapid automatic processing of linguistic input and development of sophisticated listening and memory skills. We would argue that language problems stem from a more fundamental disorder in mastering skills derived from learning complex or irregular rule systems.

The severity of the reading disability stems from the fact that the three tasks facing the child learning to read are developmentally linked or dependent on one another. Developing sophisticated reading and comprehension skills depends on having automated word decoding operations which in turn come about through mastering the symbol-sound correspondence rules.

Difficulty at the level of rule learning prevents the child from making any substantial progress beyond the rudimentary word level.

We believe that the theoretical framework proposed here integrates and organizes a good deal of evidence on reading disability. Whether the particular postulates of the theory are upheld or not, we feel that the present proposal addresses the kinds of questions which future efforts will need to take into account in giving a full explanation of the nature and causes of reading disability.

FIGURE CAPTIONS

Figure 1. Percent correct pronunciations of normal and disabled readers on consonants with one (m,a,p.t) or more then one (c) pronunciation in initial position.

Figure 2. Percent correct pronunciations on short vowels for normal and disabled readers.

Figure 3. Percent correct pronunciations on long vowels for normal and disabled readers.

Figure 4. Examples of regular and irregular rules used in color rule learning study.

Figure 5. Mean number of correctly identified colors by normal and disabled readers in the regular and irregular rule conditions across four test blocks.

Figure 6. Naming latency for words across three testing sessions as a function of word difficulty for normal and disabled readers.

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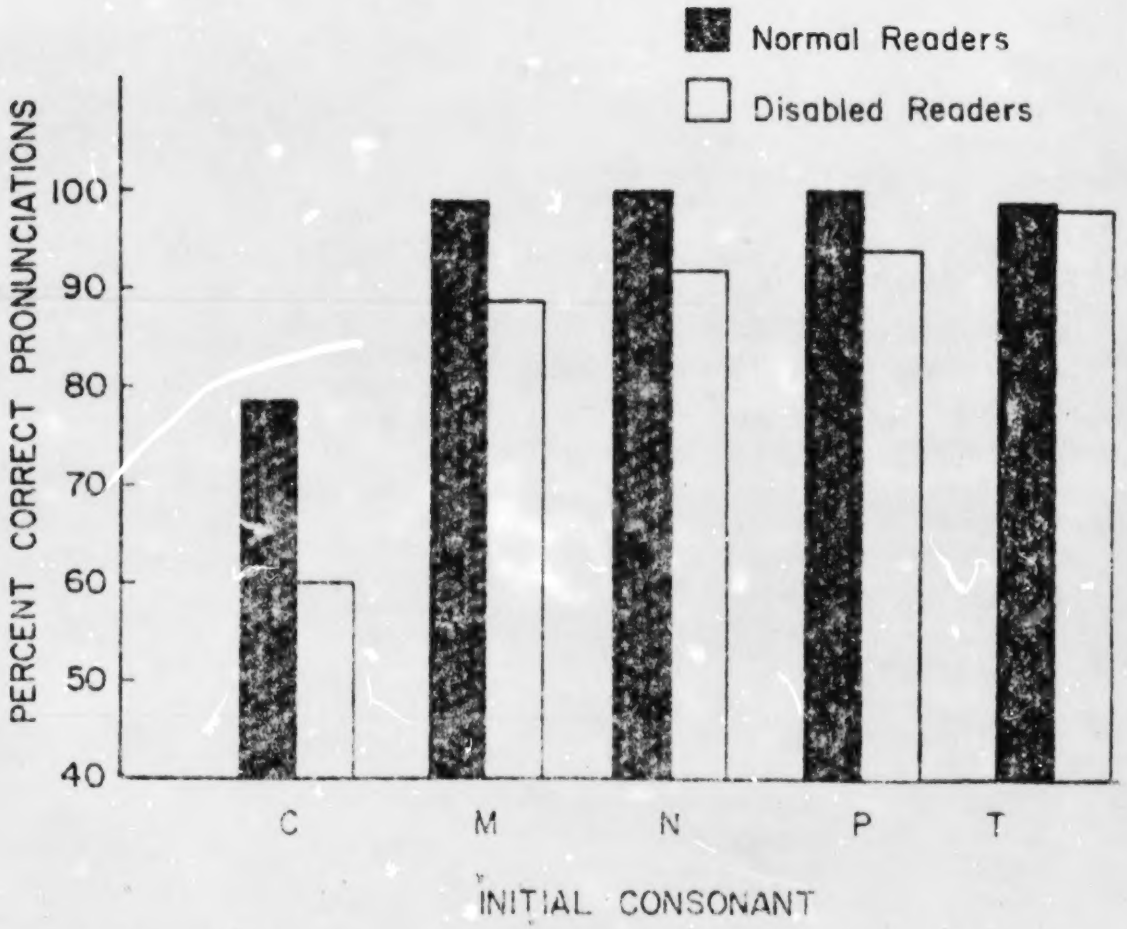
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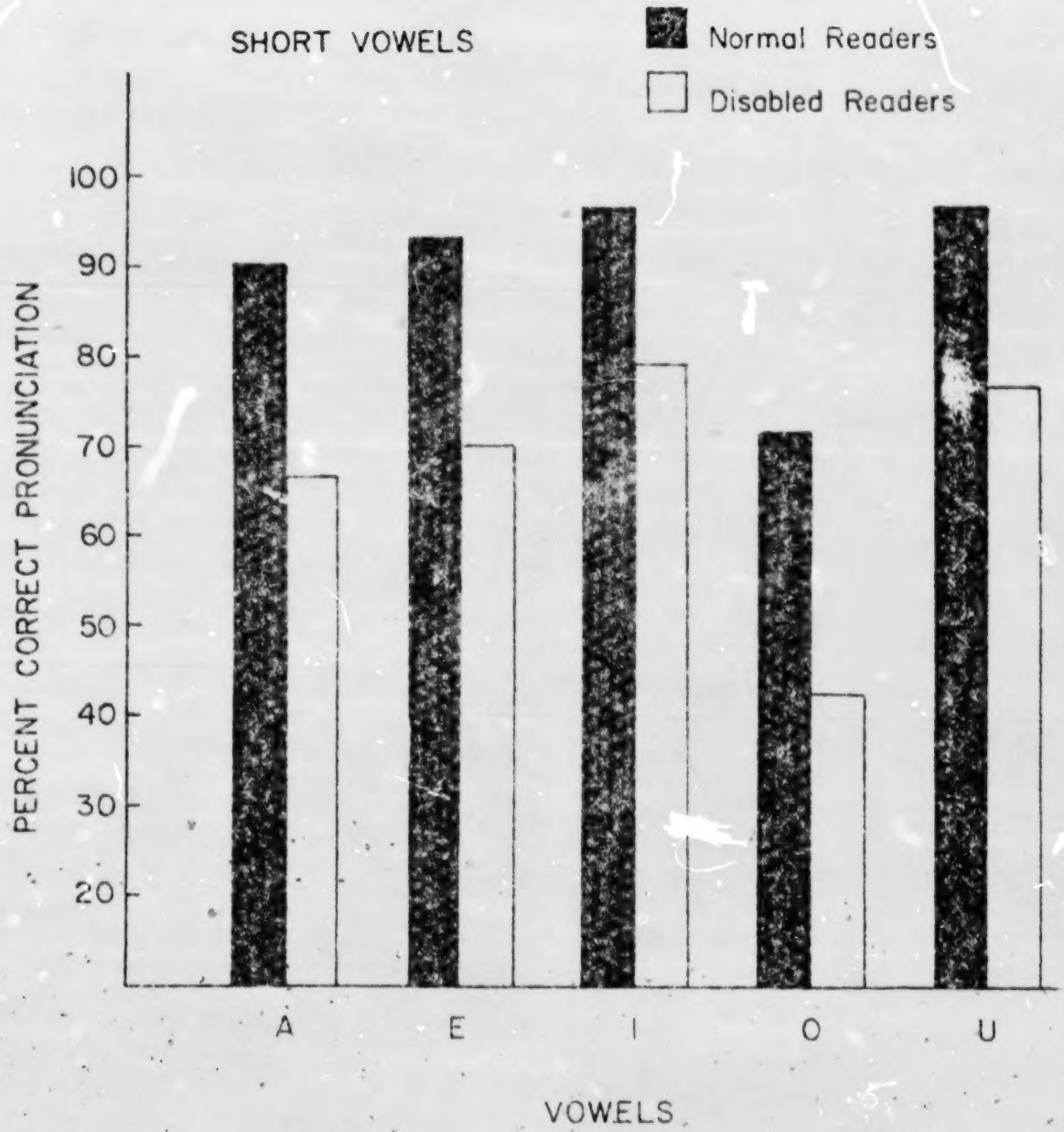
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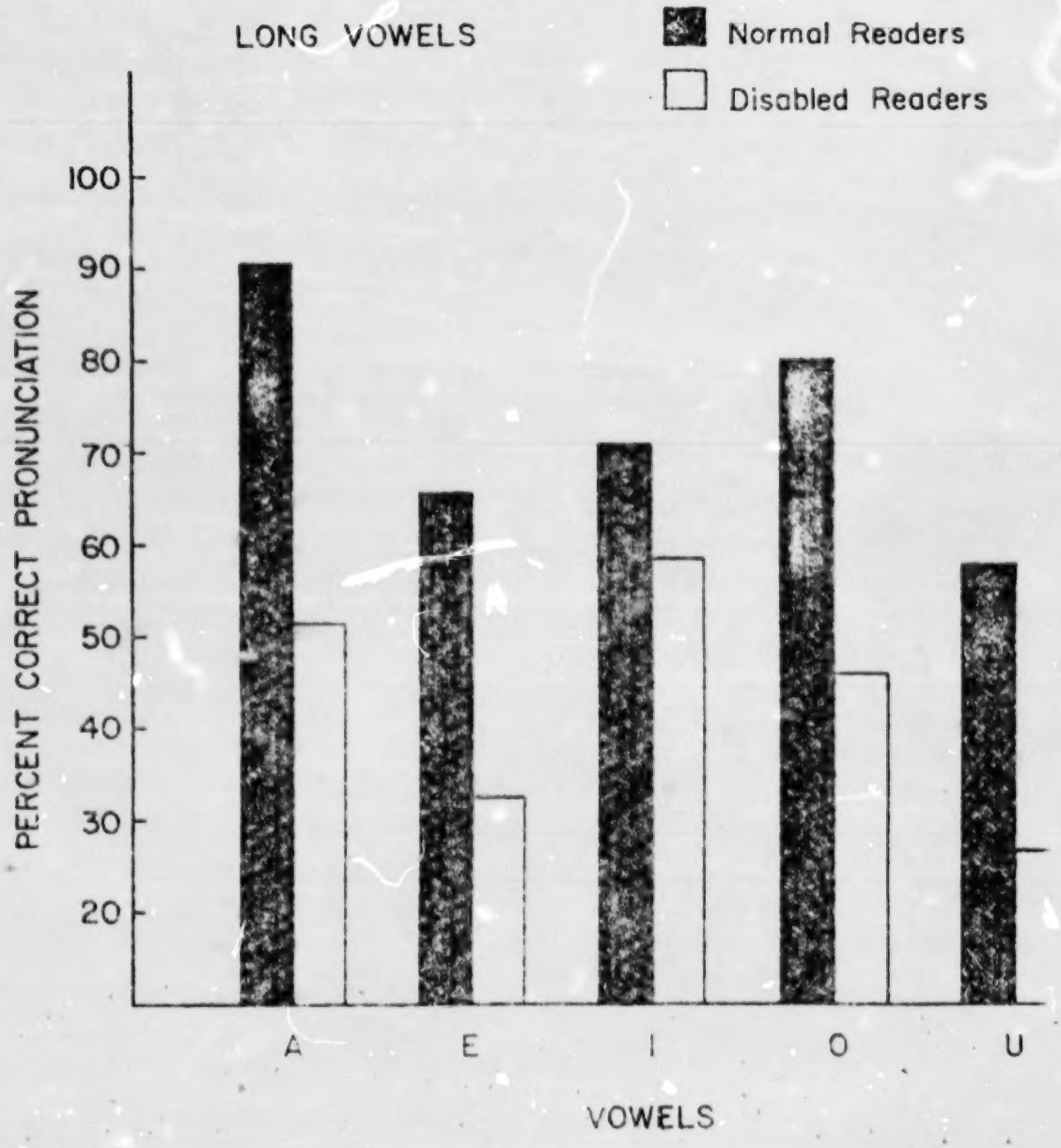
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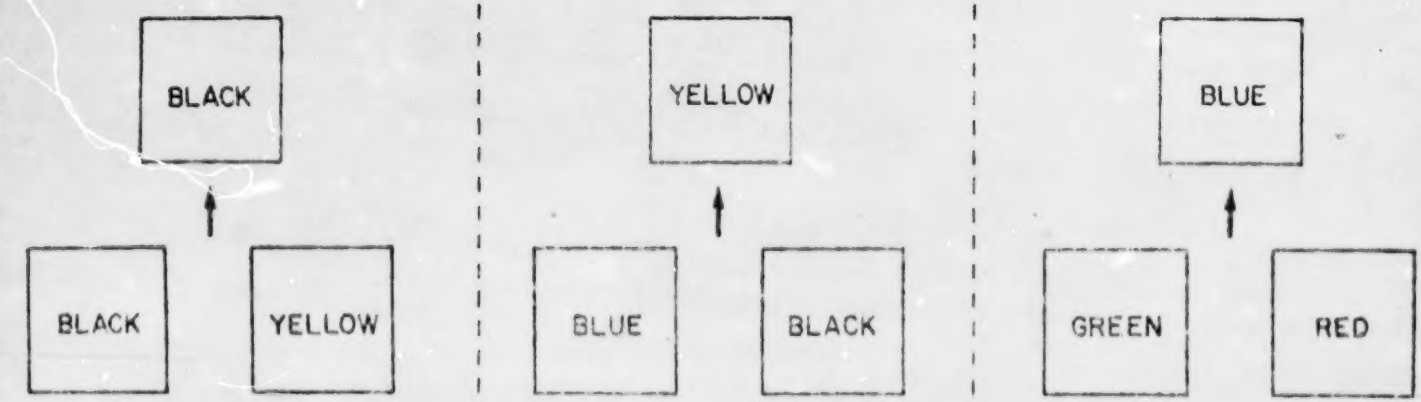

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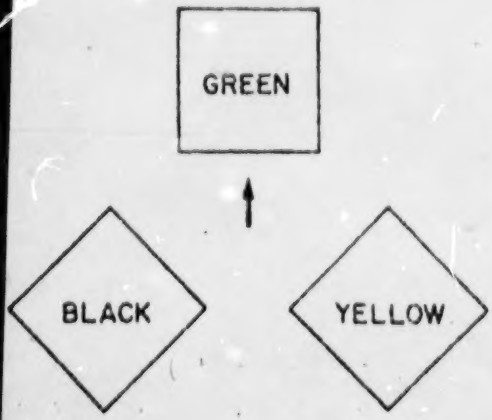

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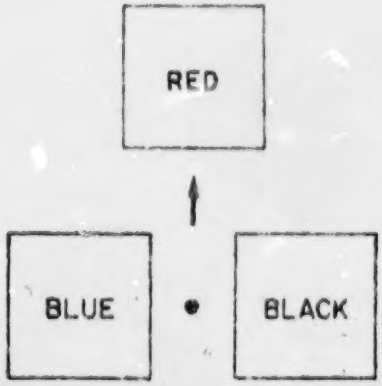

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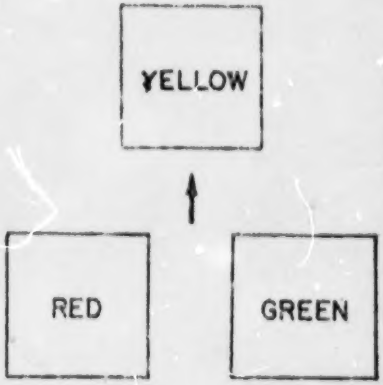

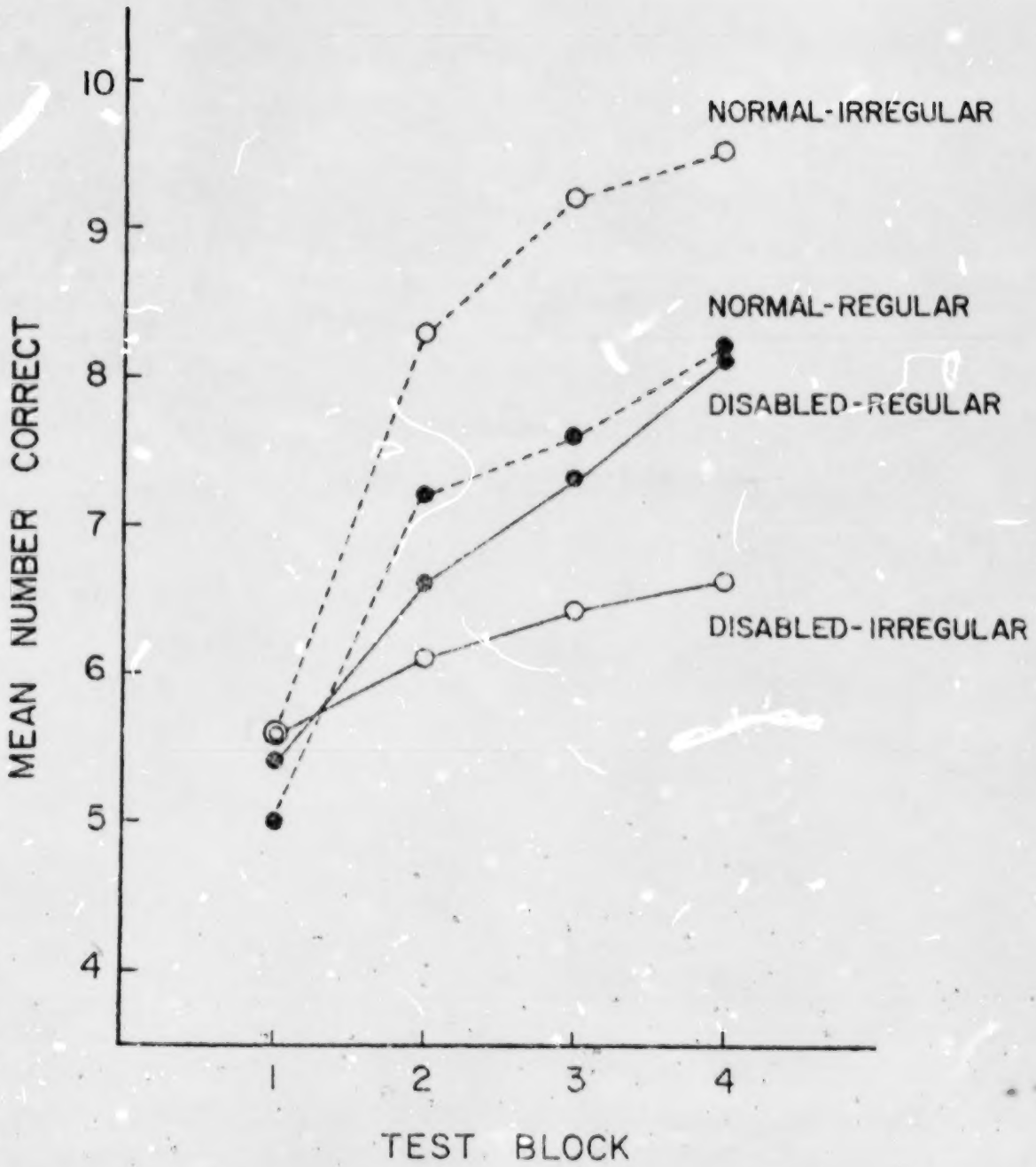
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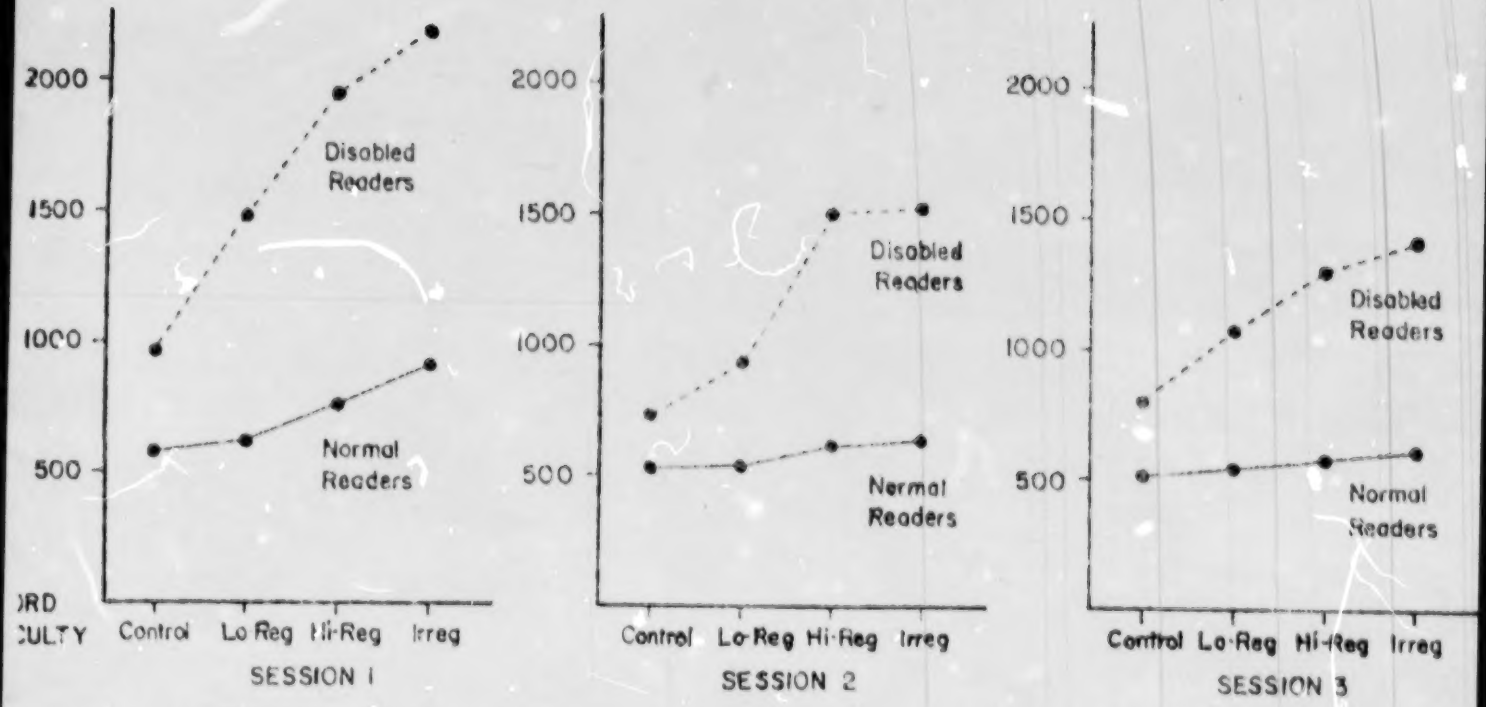
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